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Cloud Computing in the Pharmaceutical Industry

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ABSTRACT

Cloud computing is a model that provides easy and convenient access to networks everywhere. In recent years, cloud computing has emerged as a valuable technology, significantly impacting various sectors including the pharmaceutical industry. Cloud computing represents a revolutionary opportunity for pharmaceutical companies. It is transforming the pharmaceutical industry significantly. Cloud computing in the pharmaceutical industry refers to the use of remote servers on the Internet to store, manage, and process pharmaceutical data and applications. It provides Software-as-a-Service (SaaS), Infrastructure-as-a-Service (IaaS), and Platform-as-a-Service (PaaS). It offers several benefits, such as scalability, cost-effectiveness, increased accessibility, and collaboration, which have made it an attractive solution for pharmaceutical companies. In this paper, we will explore the main use cases for cloud computing in pharmaceutical industry.

KEYWORDS: *technology, cloud computing, pharmaceutical industry, pharma*

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INTRODUCTION

Technology has made great strides in transforming modern industries. It has been advancing and influencing our lives since industrialization and even before that. The cloud is a transformative force in the technology era, reshaping how businesses operate and innovate. Cloud computing is a well-established technology in the industry, providing a faster, cheaper, and more agile approach to operating IT architecture. It gives life sciences companies a flexible way to handle data storage.

Cloud computing services are one major revolution that has completely changed business functions. Cloud technologies are changing the cloud computing environment and transforming the entire computing world. Cloud transforms processes across the pharma value chain and supports the use of enabling tech like AI. Instead of using expensive physical data centers and servers, they can access remote, on-demand, storages as needed. Moving to the cloud has brought significant changes to companies of all sizes, impacting everything from business operations to internal processes [1].

Like many other industries, the pharmaceutical industry has adopted cloud computing to improve operations, data management, and collaboration. Cloud computing in the pharmaceutical market application refers to using Internet-based technology to store, manage, and access various systems. It brings flexibility, scalability, and cost-efficiency by eliminating the need for on-site hardware and infrastructure.

Some of the major players in the competitive cloud computing market in the pharmaceutical industry include Cisco Systems, IBM, Microsoft, Oracle, and Carestream Health. These companies have established themselves as key players in the competitive cloud computing market in the pharmaceutical industry through their innovative solutions, market growth, and strong market presence.

CLOUD COMPUTING BASICS

Cloud computing represents a newly emerging service-oriented computing technology. It is the provision of scalable computing resources as a service over the Internet. It allows manufacturers to

use many forms of new production systems such as 3D printing, high performance computing (HPC), industrial Internet of things (110T), and industrial robots. It is transforming virtually every facet of modern manufacturing. It is innovating, reducing cost, and bolstering the competitiveness of American manufacturing [2].

The key characteristic of cloud computing is the virtualization of computing resources and services. Cloud computing is implemented in one of three major formats: software as a service (SAAS), platform as a service (PAAS), or infrastructure as a service (IAAS). These services are illustrated in Figure 1 [3] and explained as follows:

SaaS: This is a software delivery model in which software and associated data are hosted on the cloud. In this model, cloud service providers offer on-demand access to computing resources such as virtual machines and cloud storage. Nowadays oil & gas companies transition to cloud computing and implement SaaS solutions for operations.

PaaS allows the end-user to create a software solution using tools or libraries from the platform service provider. In this model, cloud service providers deliver computing platforms such as programming and execution.

In the laaS model, cloud service providers can rent manufacturing equipment such as 3D printers.

Just like cloud computing, CM services can be categorized into three major deployment models (public, private, and hybrid clouds) [4]:

- Private cloud refers to a centralized management effort in which manufacturing services are shared within one company' or its subsidiaries. A private cloud is often used exclusively by one organization, possibly with multiple business units.
- Public cloud realizes the key concept of sharing services with the general public. Public clouds are commonly implemented through data centers operated by providers such as Amazon, Google, IBM, and Microsoft.
- Hybrid cloud that spans multiple configurations. and is a composed of two or more clouds (private, community or public), offering the benefits of multiple deployment modes.

These models are shown in Figure 2 [5]. Cloud computing finds application in almost every field.

PHARMA CLOUD COMPUTING

The pharmaceutical industry is one of the fastest growing industries in the world and has the potential to change the lives of millions of people. It is a critical sector that plays a crucial role in developing and distributing life-saving drugs and treatments. Constant and persistent innovation is the key driver of today's multibillion-dollar pharmaceutical industry. The pharmaceutical industry is represented in Figure 3 [6].

Despite the slower adoption of new technologies in the pharmaceutical industry due to strict regulations, the COVID-19 pandemic has prompted companies in this sector to reconsider their legacy operations. Cloud computing has evolved to address key concerns in the pharmaceutical industry including privacy, security, and compliance issues. It provides a more agile approach to operating IT architecture; it helps pharma companies to cut costs by removing the need to invest in access IT hardware and software as needed, rather than buying assets upfront. Cloud utilization has the potential to revolutionize the pharmaceutical industry by improving efficiency, reducing costs, and enabling innovative solutions.

APPLICATIONS OF CLOUD COMPTING IN PHARMACEUTICALS

Pharma companies around the world are tapping into the possibilities that are inherent to cloud computing. They are using it in various areas, such as designing clinical trials and track-and-trace management. There are countless possible ways of application, all of which can improve efficiency in some way. During COVID, cloud-based tools allowed pharma companies to capture and share clinical data between research teams both securely and quickly. Vaccines were delivered worldwide in record time, saving millions of lives. Common applications of cloud computing in pharmaceutical industry include the following [7]:

- *Clinical Trials:* The clinical trial design process also benefits significantly from cloud adoption by pharmaceuticals. The traditional clinical trial model is inconvenient and taxing for patients. Cloud computing can be a valuable tool in designing clinical trials, as it can help to streamline the process of patient recruitment for the various sites. Instead of holding data and information across multiple organizations, the data can be hosted in the cloud. Why do so many patients leave the clinical trials? Many are still designed with life sciences companies in mind, requiring patients to make frequent hospital visits without compensation for their time or effort. Cloud computing is helping to change this by enabling decentralized clinical trials, which offer an innovative solution to the issues of the traditional clinical trial model.

- *Drug Discovery:* One of the biggest pros of cloud computing in pharmaceutical industry is drug discovery. Drug discovery and research is a place where healthcare and cloud computing meet to unleash new opportunities for pharmaceutical companies. A single drug's research and development can take many years. Cloud computing accelerates drug discovery. The gap between companies investing in cloud technologies and those avoiding it is set to grow. Research teams can collaborate and share their findings securely and efficiently. This allows scientists to analyze lab results and draw conclusions more quickly. For example, AstraZeneca, which relies on cloud solutions to accelerate drug research and development, will likely get products to market faster than any company that has resisted this digital transformation. In drug discovery and development, cloud computing allows for secure R&D collaborations between research teams. It simplifies data transfer from laboratory equipment and can enable scientists to analyze results and generate outcomes faster. Cloud computing is also important in supporting other emerging technologies in drug discovery and development, such as big data and AI. In drug discovery and development, cloud computing can enable scientists to analyze results and generate outcomes faster. Figure 4 shows some drugs [8], while Figure 5 displays some scientists [9].
- *Supply Chain Management*: Cloud computing in pharma also impacts logistics and supply chains. Pharmaceutical companies must deal with complex supply chains, which are often inefficient and vulnerable to infrastructure and performance issues. Supply chain disruption will continue as populations grow, particularly in countries with reduced supply chain infrastructure. Digitalizing data collection in supply chains and moving it to the cloud provides companies with real-time insights into the state of a supply chain, helping them anticipate shortages, reduce errors, forecast demand, and enhance compliance checks and traceability. Pharma companies can benefit the most from adopting cloud computing in supply chain management, particularly those producing complex drugs, such as vaccines and cell therapies, which require specific manufacturing processes, storage, and transportation conditions.
- *Healthcare:* The importance of cloud computing in the healthcare setting is hard to deny. Cloud software solutions are finding their way to different healthcare practices. The adoption of cloud computing in healthcare has significantly boomed in the past few years. Cloud computing in healthcare refers to the use of remote servers hosted on the Internet to store, manage, and process healthcare data and applications. Cloud-based systems enable remote access to patient records and healthcare applications from anywhere with an Internet connection, improving accessibility and flexibility for healthcare providers. Cloud computing in healthcare improves hospital management on many levels. Figure 6 shows use cases of cloud computing in healthcare [10].

BENEFITS

Cloud computing offers a multitude of benefits to pharma companies. Pharmaceutical companies could use cloud-based analytics to understand patients by using these tools for managing patient records through various apps. Cloud-based systems help eliminate data silos, allowing companies to better use their data to drive business growth. Cloud computing provides various benefits, from securing R&A collaborations between research teams and capturing big data sets from clinical trials to accelerating regulatory submission procedures and improving sales data collection. Other significant benefits of cloud computing in pharma include the following [11,12]:

- *Cost Savings:* A key advantage of cloud computing in the pharmaceutical industry is cost savings. Cloud computing helps the pharmaceutical industry become more cost-effective by reducing the costs associated with IT infrastructure, data storage, and drug development. Taking your IT-dependent services into the cloud requires far less up-front investment than traditional IT models. Instead of investing large sums in the purchase of equipment and systems, you can realize immediate savings by tapping into the resources of your cloud computing service provider.
- *Regulations:* Pharmaceutical regulations change and evolve rapidly, making compliance quite tricky. Cloud computing can help companies across healthcare to comply with industry regulations. Cloud technology helps life sciences companies navigate a heavily regulated industry without the need to gather physical dossiers. The regulatory submission process has become much smoother and quicker. The data submitted to the cloud lets regulators perform instant analysis and expedite approvals. The regulatory submission process has become much smoother and quicker.

The regulatory bodies can now access company data directly from cloud servers and track drug safety in real-time. Cloud computing could also pose a risk to a healthcare organization's ability to comply with regulations.

- *Pharmacovigilance:* Traditional pharmacovigilance leads to time-consuming manual reporting. Cloud computing makes real-time monitoring possible, allowing timely detection of drug safety signals. Real-time monitoring of a drug's location drastically reduces the possibility of errors and prevents counterfeiting.
- *Data Protection:* Data privacy and sovereignty are two of the largest barriers to the implementation of cloud computing in the pharma industry. Pharmaceutical companies spend a fortune on obtaining and maintaining quality data. Not only it is expensive to gain access to all this information, but it is also challenging to keep the data in a secure and safe location. Storing your data in the cloud allows you to do precisely that, with 24/7 access to it from anywhere in the world.
- *On-Demand Access:* There is no need to request more storage space or additional time on the server. The service is continuously there and responsive to your needs, and available on any device that has a web browser.
- *Scalability:* Depending on whether you scale your pharma operations up or down, your data storage needs can change quickly. By storing your data in the cloud, you eliminate both the additional expense and the time investment it would take to perform the upgrade.
- *Enhanced Collaboration*: Cloud computing facilitates effortless collaboration. It makes it easier for life sciences companies to communicate and collaborate globally. Cross-company communication and collaboration are essential to running a successful pharmaceutical operation. The cloud environment enhances your company's ability to communicate and share data outside of traditional methods. Today, cloud-based collaboration tools help stakeholders keep communication open at every product lifecycle stage, from discovery to manufacturing. Real-time collaboration and sharing of data and information between individuals, teams, and organizations are made possible through cloud-based tools and platforms.
- *Automatic Updates:* Cloud computing allows for automatic updates so that your system always has the most up-to-date technology. These updates can improve your software, servers, computer processing power or a combination of these.
- *Business Continuity:* Another significant impact of pharma cloud computing is in business continuity. It ensures redundancy, disaster recovery, and high availability. In simple terms, if there is a natural disaster, hardware glitch, or cyberattack, data stored in the cloud stays accessible from anywhere with the Internet.
- *Global Accessibility:* Cloud technology means global accessibility for pharmaceutical companies regardless of location. Pharmaceutical companies can access their data and tools from anywhere with Internet access, allowing seamless collaboration, communication, and faster decision-making. For example, a pharmaceutical company conducting clinical trials in multiple locations can easily share real-time data and updates with researchers, doctors, and regulators worldwide.
- *AI Integration:* Cloud computing also enables the pharmaceutical industry to embrace new technologies, such as artificial intelligence (AI) and the Internet of Things (IoT). For example, AI-based cloud solutions like clinical decision support systems (CDSS) collect relevant data in a single place, helping healthcare specialists improve the accuracy of their diagnoses and make their decisions data-driven. AI also enables predictive analytics to identify risks and trends before they grow into serious issues. AI and ML help pharma companies with discovering drugs, designing clinical trials, predicting patient outcomes, and personalizing treatments. They also play a key role in automating data analysis, image recognition, and natural language processing.

Some of these benefits are displayed in Figure 7 [8].

CHALLENGES

There are several prominent cloud security challenges in the pharmaceutical industry. The processes organizations use to discover and develop new products remain the same, innovation has declined, and regulations are becoming more onerous, while market conditions are getting harsher with global healthcare costs rising. Changing the discovery and development process will be essential in shaping the pharmaceutical sector and in addressing some of its key challenges. Cloud computing can facilitate faster innovation. Other challenges include the following [12]:

- *Data Security:* Anything connected to the Internet can be vulnerable to cyberattacks. Cloud

infrastructures are prone to insider threats, distributed denial-of-service (DDoS) attacks, ransomware, and data breaches, among other cyberthreats. Many pharmaceutical organizations entrust their data and applications to third-party cloud services via external service providers. Moving your data from in-house servers to the cloud exposes your system to potential security risks. Addressing the specific security concerns inherent in cloud computing within the pharmaceutical industry is pivotal for safeguarding sensitive data and ensuring regulatory compliance. Cloud computing provides secure data sharing for clinical trials. Cloud offers a high level of security measures to protect sensitive information. This includes encryption, multi-factor authentication, and physical security measures.

- *Data Sovereignty:* This is another key concern for most pharmaceutical brands as they decide whether to move to the cloud. Personal data is subject to the legal regulations of the country where the individual resides, which can make cloud adoption painful. Data sovereignty poses an issue for pharma wishing to work with cloud providers which do not have a data center in the same country. For example, if you are based in Ghana and want to work with a trusted provider like AWS, you could run into data sovereignty issues,
- *Trust:* Security and privacy are paramount in the pharma industry. Cloud data centers take every care to ensure your organization meets the compliance requirements of regulators. Periodic updates and automatic security patches ensure data safety.

CONCLUSION

Pharmaceutical companies deal with a vast amount of sensitive and intellectual data daily. This together with compliance and regulatory guidelines holds them from adopting cloud technology. Pharma is known as the industry which is slower in adopting ground-breaking technologies than other fields or businesses. But cloud computing is key for pharmaceutical companies since it is transforming the way the pharmaceutical industry works. It cuts costs, offers real-time data, and fosters global collaboration.

Cloud computing has become a key technology for the pharmaceutical industry due to its ability to store, analyze, and share large amounts of data securely. It is transforming the pharmaceutical industry, providing companies with new and innovative ways to improve their operations. Pharmaceutical companies should consider making cloud computing an integral part of their business. Cloud computing has a promising future in the pharmaceutical industry, as it offers significant advantages in terms of data management, collaboration, and cost-efficiency. The global cloud computing market in the pharmaceutical industry is witnessing several emerging trends.

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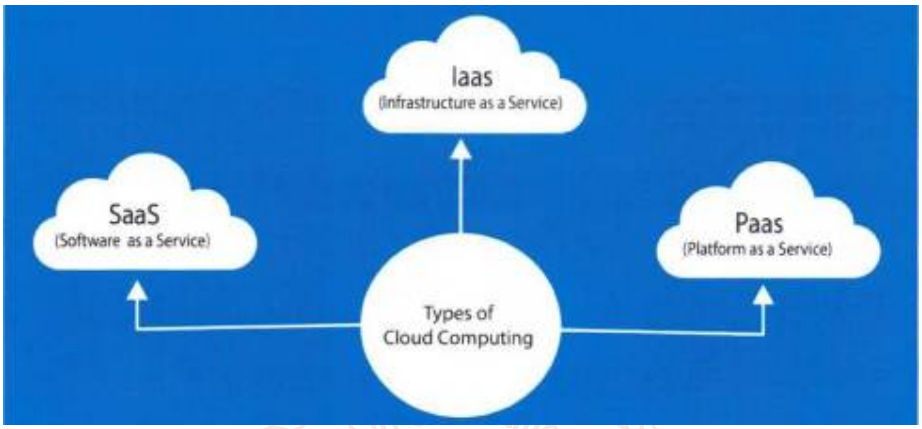


Figure 1 Three types of cloud computing services [3].

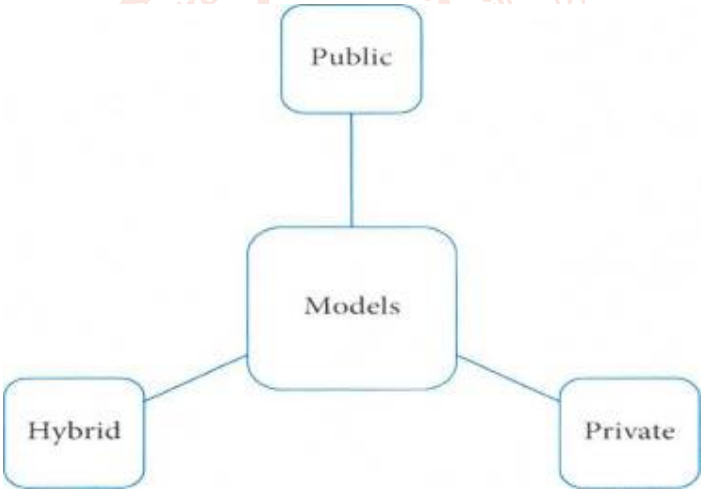


Figure 2 Cloud computing models [5].



Figure 3 A representation of the pharmaceutical industry [6].



Figure 4 Some drugs [8].



Figure 5 Some scientists [9].

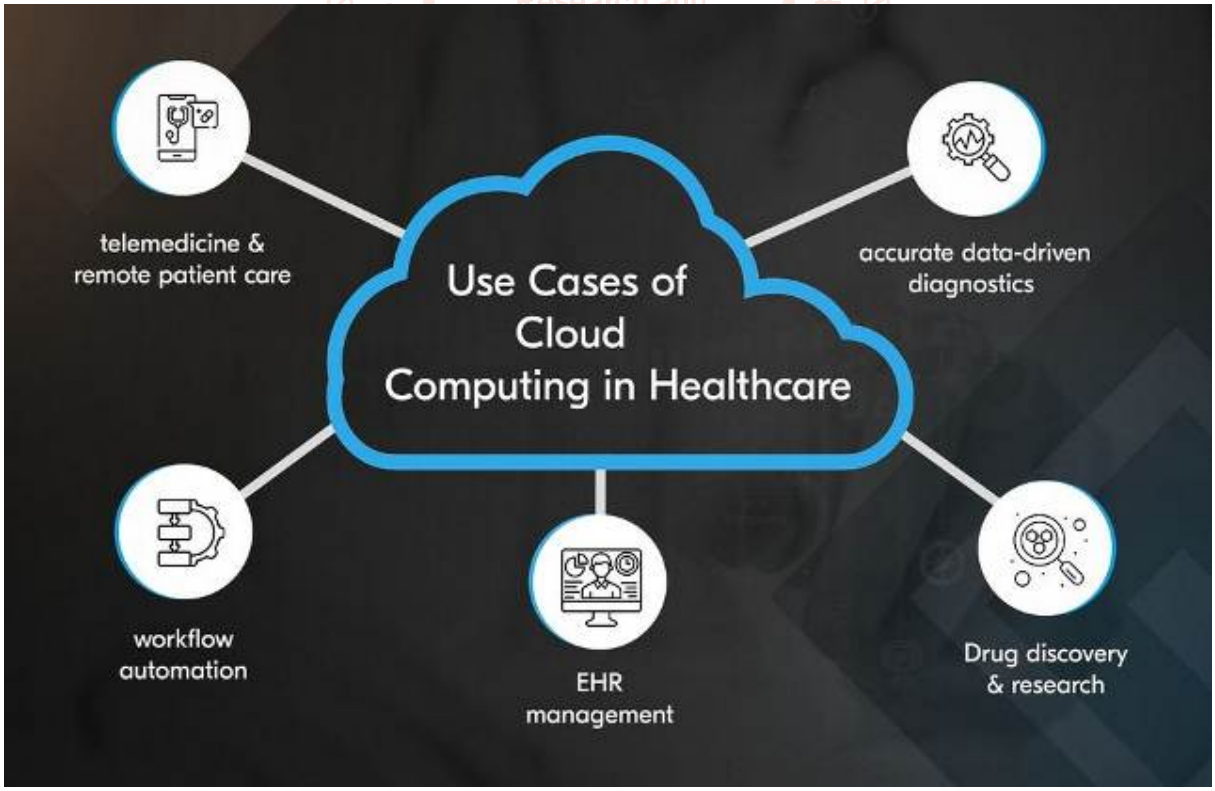


Figure 6 Use cases of cloud computing in healthcare [10].

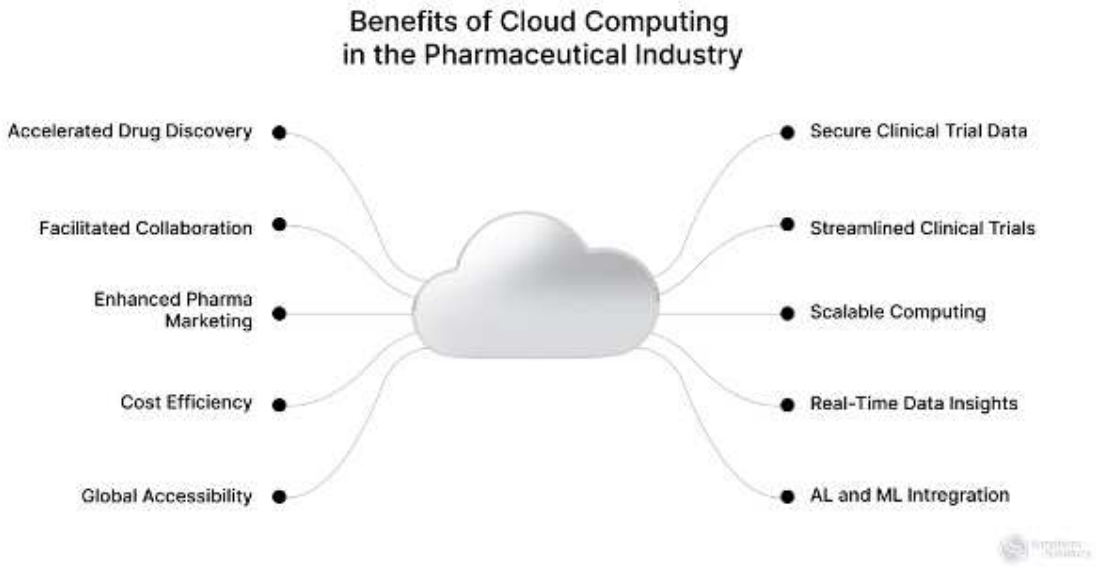


Figure 7 Benefits of cloud computing in pharma [8].

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